

530,197

10/530197

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property
Organization
International Bureau



(43) International Publication Date
15 April 2004 (15.04.2004)

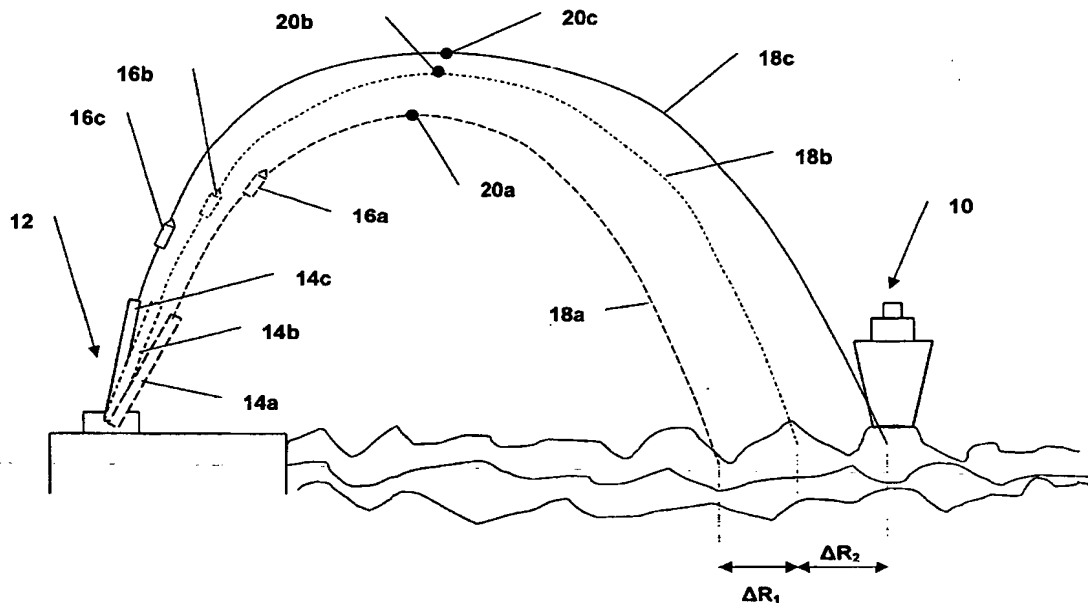
PCT

(10) International Publication Number
WO 2004/031680 A1

- (51) International Patent Classification⁷: **F41G 3/14** (74) Agent: **GROUP IP DEPARTMENT BAE SYSTEMS PLC**; PO Box 87, Lancaster House, Farnborough Aerospace Centre, Farnborough, Hampshire, GU14 6YU (GB).
- (21) International Application Number: **PCT/GB2003/004210**
- (22) International Filing Date:
30 September 2003 (30.09.2003)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:
0223437.5 3 October 2002 (03.10.2002) GB
- (71) Applicant (for all designated States except US): **ALENIA MARCONI SYSTEMS LIMITED** [GB/GB]; Eastwood House, Glebe Road, Chelmsford, Essex CM1 1QW (GB).
- (72) Inventor; and
(75) Inventor/Applicant (for US only): **NURSE, Francis, Edward, Charles** [GB/GB]; AMS Radar Systems, Newport Road, Cowes, Isle of Wight, PO31 8PF (GB).
- (81) Designated States (national): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.
- (84) Designated States (regional): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).
- Published:
— with international search report

[Continued on next page]

(54) Title: IMPROVEMENTS IN OR RELATING TO TARGETING SYSTEMS



(57) Abstract: Described herein is a method of controlling the operation of a missile launcher (12) by predicting the landing position (22) of a missile (16) in flight before it lands. The method includes tracking the missile (16) as it travels along its trajectory (18) until it reaches its apogee (20) and calculating the landing position (22) to provide a feedback correction signal to launcher (12) for the next missile to be launched. By utilising a feedback correction signal in this way, the time to hitting a target (10) from the time of engagement is substantially reduced.

WO 2004/031680 A1

WO 2004/031680 A1



For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

- 1 -

IMPROVEMENTS IN OR RELATING TO TARGETING SYSTEMS

The present invention relates to targeting systems and is more particularly concerned with a control system for such systems.

5 In conventional targeting systems, a shell is fired from a barrel towards a target and, depending on where the shell lands, the targeting system is adjusted to improve the accuracy of the position of where the next shell fired lands. This process is repeated until a shell hits the target and then no further adjustment is required as subsequent shells should be on target.

10 As the time to acquire an exact 'lock' on the target may be protracted, a number of shells may be wasted in the process of acquiring the range to hit the target. This has the consequence of reducing the overall life of the barrel from which the shell is fired.

It is therefore an object of the present invention to provide an improved targeting system which overcomes the disadvantages mentioned above.

15 In accordance with one aspect of the present invention, there is provided a method of controlling the operation of a missile launcher which fires free fall ballistics missiles, the method comprising the steps of:

- a) firing a missile from the missile launcher;
- b) tracking the trajectory of the fired missile;
- 20 c) calculating a predicted point of impact of the missile after it reaches its trajectory apogee;
- d) feeding back the predicted point of impact to the missile launcher before the missile impacts;
- e) applying a correction prior to firing a subsequent missile; and
- 25 f) repeating steps a) to e) until the missile impacts a chosen target.

Advantageously, step d) comprises feeding back the predicted range of the missile.

- 2 -

In accordance with a second aspect of the present invention, there is provided a control system for a free fall ballistics missile fired from a missile launcher, the control system including:-

tracking means for tracking the trajectory of a missile fired from the
5 missile launcher;

calculation means for calculating a predicted point of impact of the missile, the calculation means being operable immediately after the missile reaches its trajectory apogee; and

feedback means for feeding back the predicted point of impact to the
10 missile launcher so that a correction can be applied before the fired missile makes impact prior to the launch of subsequent missile.

Advantageously, the calculation means comprises a processor connected to receive data from the tracking means and to provide data relating to the predicted point of impact in the form of range information.

15 It is preferred that the processor includes the feedback means.

In one embodiment of the present invention, the tracking means comprises a tracking radar system which recognises the missile as it is fired from the missile launcher.

In accordance with a further aspect of the present invention, there is
20 provided a targeting system including a control system as described above.

For a better understanding of the present invention, reference will now be made, by way of example only, to the accompanying drawings in which:-

Figure 1 illustrates a missile launcher firing a missile towards a target in accordance with the present invention; and

25 Figure 2 is a block diagram of a control system in accordance with present invention.

Referring initially to Figure 1, a target 10 is shown being fired upon by a launcher system 12. For example, the target 10 may comprise a first ship and

- 3 -

the launcher system 12 may be mounted on a platform located on land or on another ship. Only the barrel 14 of the launcher system 12 is shown for clarity.

When the target 10 is determined to be hostile and it is decided to fire on it, the launcher system 12 is positioned so that the barrel 14 is angled in position 14a to fire a shell 16a which follows a trajectory 18a. The trajectory 18a passes through an apogee 20a before splashing down at 22a and misses the ship 10.

In accordance with the present invention, a radar system (not shown) associated with the launcher system 12 tracks the shell 16a as it exits barrel 14a until it reaches the apogee 20a of its trajectory. From the data collected by the radar system up to the apogee 20a, it is possible to calculate the landing position 22a before the shell 16a reaches that position, and hence provide a range correction, ΔR_1 , for the launcher system 12. This range correction effectively moves the barrel 14 to position 14b ready to fire another shell 16b before shell 16a hits position 22a.

Shell 16b follows trajectory 18b and has an apogee at 20b. However, although landing position 22b of shell 16b is nearer the ship 10, a further range correction, ΔR_2 , is required. As before, the further range correction is calculated before shell 16b reaches landing position 22b, and is applied to move the barrel 14 to position 14c ready to fire a further shell 16c before shell 16b hits position 22b.

Shell 16c follows trajectory 18c and has an apogee at 20c. In this case, it is calculated that landing position 22c of shell 16c is coincidental with the ship 10 before shell 16c reaches that position and at least one further shell (not shown) can be directed along substantially the same trajectory as trajectory 18c to impact the ship 10.

Turning now to Figure 2, a block diagram illustrating a control system 30 for launcher 12 of Figure 1 is shown. The control system 30 comprises a target acquisition unit 32 which provides initial targeting instructions for a launcher control unit 34 which launches a shell 16a from a barrel 14 (Figure 1). The launcher control unit 34 is connected to a tracking radar unit 36 and a processor

- 4 -

unit 38. The target acquisition unit 32 is also connected to tracking radar unit 36 and the processor unit 38 as shown.

When the target acquisition unit 32 provides the initial targeting instructions to the launcher control unit 34 via link 40, it provides the same instructions to the tracking radar unit 36 and the processor unit 38 via links 42 and 44 respectively. These instructions establish the starting point from which the tracking radar unit 36 provides data relating to the trajectory of a shell which is launched using those instructions, and from which the processor unit 38 calculates the range correction data for the launcher control unit 34.

The launcher control unit 34 provides data relating to the shell (not shown) which is to be launched by the launcher (not shown) to the tracking radar unit 36 over the link 46. This data provides the tracking radar unit 36 with details of how to recognise the shell which it is to track before or as the shell is launched. The launcher control unit 34 also provides data relating to launch of the shell to the processor unit 38 over link 48. Data from the tracking radar unit 36 is fed via link 50 to the processor unit 38, so that the processor unit 38 can calculate the predicted location of the shell impact once the apogee of the trajectory of the shell has been achieved, and provide range correction data for the launcher control unit 34 over link 52.

It will be appreciated that once the tracking radar unit 36 has established a settled track on a shell which has been launched from a launcher (not shown) associated with the launcher control unit 34, the data sent to the processor unit 38 from that settled track allows the predicted shell impact location to be determined with some accuracy. The accuracy of the predicted shell impact location will improve as a function of time, and it has been determined that a while after the shell has reached the apogee of its trajectory, the accuracy of the predicted shell impact location is adequate to use as the basis for a feedback signal for the launcher control unit 34 to correct the elevation of the barrel of the launcher. This has the advantage that the predicted range of the shell is known at a time considerably before the shell impacts and the launch control unit 34 can apply a correction to a second shell from a shell which is yet to land.

- 5 -

It will readily be understood that a filtering process can be used to provide a best estimate of the predicted shell impact location.

Moreover, the system of the present invention has the advantage that the number of shells which need to be fired in an engagement, from the start of the engagement to hitting the target, can be substantially reduced. The time involved is also reduced. This, in turn, has the advantage that barrel life of the launcher can be extended in proportion.

Although the present invention has been described with reference to determining the landing position of a shell, it will be understood that the invention can be applied to any free fall ballistics missile. Furthermore, the invention can be used with any stationary or relatively slowly-moving target.

- 6 -

CLAIMS

1. A method of controlling the operation of a missile launcher which fires free fall ballistics missiles, the method comprising the steps of:

a) firing a missile from the missile launcher;

5 b) tracking the trajectory of the fired missile;

c) calculating a predicted point of impact of the missile after it reaches its trajectory apogee;

d) feeding back the predicted point of impact to the missile launcher before the missile impacts;

10 e) applying a correction prior to firing a subsequent missile; and

f) repeating steps a) to e) until the missile impacts a chosen target.

2. A method according to claim 1, wherein step d) comprises feeding back the predicted range of the missile.

3. A control system for a free fall ballistics missile fired from a missile launcher, the control system including:-

tracking means for tracking the trajectory of a missile fired from the missile launcher;

calculation means for calculating a predicted point of impact of the missile, the calculation means being operable immediately after the missile reaches its trajectory apogee; and

20 feedback means for feeding back the predicted point of impact to the missile launcher so that a correction can be applied before the fired missile makes impact prior to the launch of subsequent missile.

4. A control system according to claim 3, wherein the calculation means comprises a processor connected to receive data from the tracking means and to provide data relating to the predicted point of impact in the form of range information.

- 7 -

5. A control system according to claim 4, wherein the processor includes the feedback means.
6. A control system according to any one of claims 3 to 5, wherein the tracking means comprises a tracking radar system.
- 5 7. A control system according to claim 6, wherein the tracking radar system recognises the missile as it is fired from the missile launcher.
8. A targeting system including a control system according to any one of claims 3 to 7.
9. A method of controlling the operation of a missile launcher substantially
10 as hereinbefore described with reference to the accompanying drawings.
10. A control system substantially as hereinbefore described with reference to the accompanying drawings.

1/2

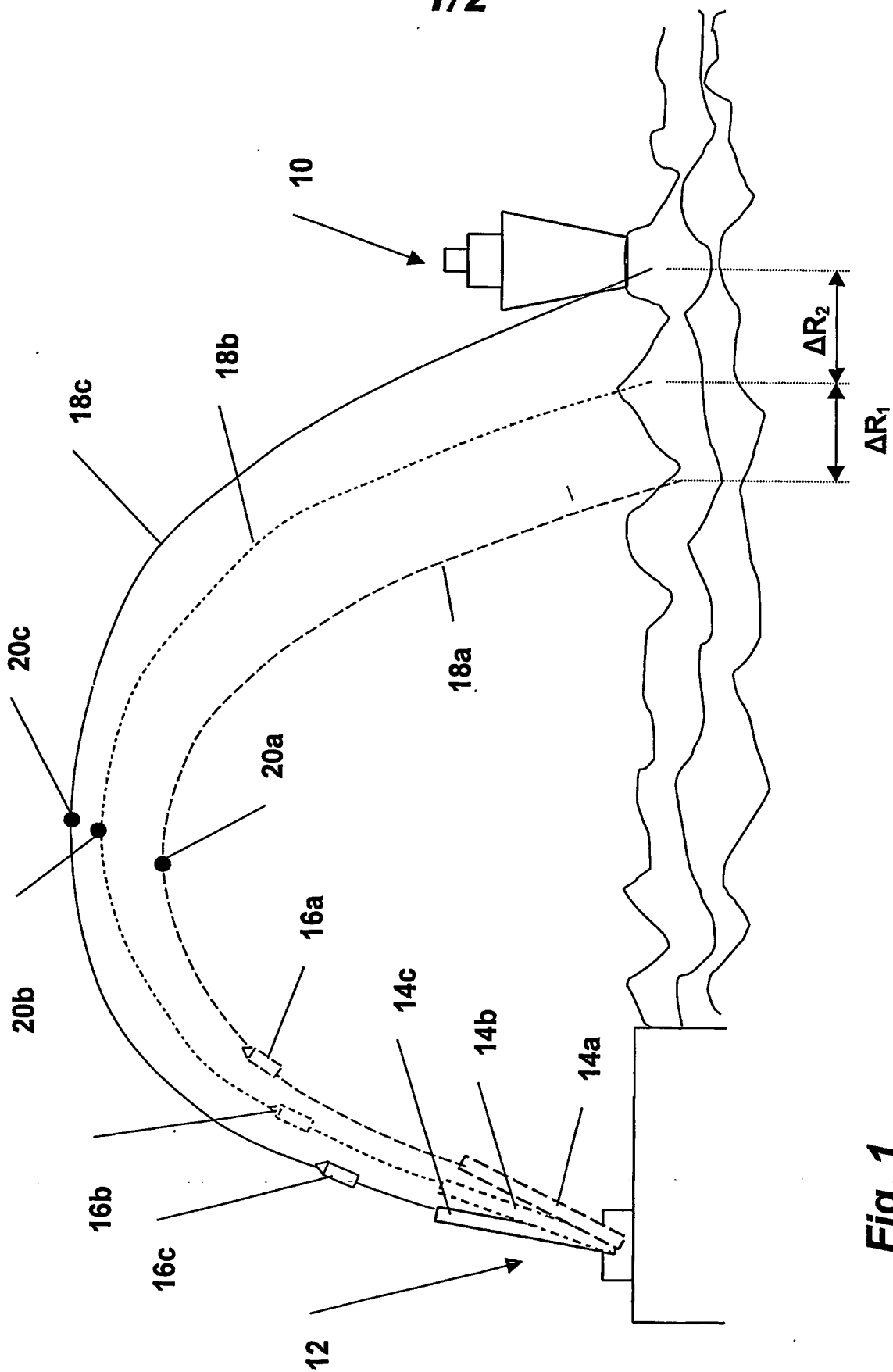


Fig. 1

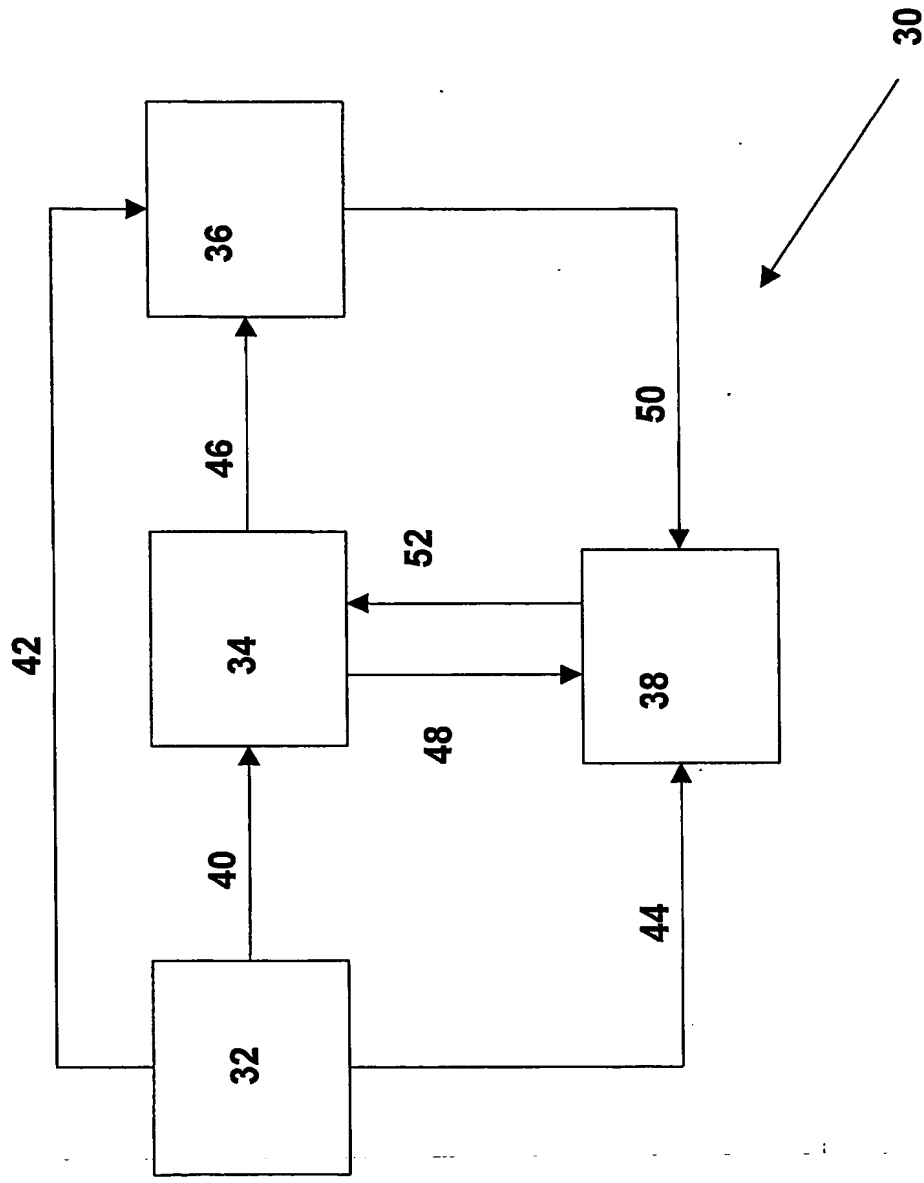


Fig. 2

INTERNATIONAL SEARCH REPORT

Inte Application No
PCT/03/04210

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 F41G3/14

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 F41G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 90 08936 A (CONTRAVES AG) 9 August 1990 (1990-08-09)	1,3,8
A	abstract page 13, line 28 -page 16, line 10; figures 1,2	2,4-7
A	WO 98 14747 A (BARR & STROUD LTD ; HUMPHREYS DAVID KERR PATERSON (GB)) 9 April 1998 (1998-04-09)	1-8
A	abstract page 6, line 37 -page 15, line 19; figures 1-8	
A	EP 0 261 091 A (BOFORS AB) 23 March 1988 (1988-03-23)	1,3,8
	abstract page 2, column 2, line 30 -page 3, column 4, line 8; figures 1-4	

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

13 January 2004

Date of mailing of the international search report

26/01/2004

Name and mailing address of the ISA

European Patent Office, P.B. 6818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

Authorized officer

Blonde1, F

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/03/04210

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
WO 9008936	A	09-08-1990	BR 9004712 A CA 2023659 A1 WO 9008936 A1 EP 0411073 A1	30-07-1991 25-07-1990 09-08-1990 06-02-1991
WO 9814747	A	09-04-1998	DE 69720749 D1 EP 0929787 A1 WO 9814747 A1 US 6260466 B1	15-05-2003 21-07-1999 09-04-1998 17-07-2001
EP 0261091	A	23-03-1988	SE 460501 B BR 8704785 A EP 0261091 A2 SE 8603911 A	16-10-1989 17-05-1988 23-03-1988 18-03-1988